Three-Dimensional Models of Covalent Molecules

Pre-Lab Discussion

A *single covalent bond* is formed when two atoms share a pair of electrons. Each atom provides one of the electrons of the pair. If the two atoms are alike, the bond is said to be *nonpolar covalent.* If the atoms are unlike, one exerts a greater attractive force on the electrons, and the bond is *polar covalent.* More than one pair of electrons can be shared. This results in a double or triple bond.

A group of atoms held together by covalent bonds is called a *molecule.* Molecules can be either polar or nonpolar. If bonds are nonpolar, the molecule is nonpolar. If bonds are polar, molecules can still be nonpolar if the charge distribution throughout the molecule is symmetrical. A molecule's symmetry depends on its shape, that is, the positions in space of the atoms making up the molecule. Some possible shapes are linear, angular (bent), pyramidal, and tetrahedral.

Although we represent molecules on paper as being two-dimensional for convenience, they are actually three-dimensional. By building molecular models, chemists come to understand the bonding, shapes, and polarity of even the most complex molecules.

Purpose

Build three-dimensional models of some simple covalent molecules. Predict their shapes and polarities from knowledge of bonds and molecule polarity rules.

Equipment

molecular model building set

Safety

All general lab safety rules should be followed. Always wear safety goggles and a lab apron or coat when working in the lab.

Procedure

1. Obtain a molecular model building set. Study the color code identifying the different kinds of atoms.
2. Observe that the following atoms have one hole (bonding site): hydrogen, fluorine, chlorine, bromine, and iodine. The atoms with two holes are oxygen and sulfur. A nitrogen atom has three holes, and a carbon atom has four holes.
3. Construct models of the following molecules:

H_2	HF	CH_3OH
H_2O	C_2H_2	H_2O_2
CH_4	CH_2Cl_2	O_2
Cl_2	N_2	H_2S
NH_3	CO_2	

4. Record your observations below. → Next Page

Observations and Data

Name	Formula	Structural representation	Shape	Molecule polarity
hydrogen	H_2			
water	H_2O			
methane	CH_4			
chlorine	Cl_2			
ammonia	NH_3			
hydrogen fluoride	HF			
dichloromethane	CH_2Cl_2			
nitrogen	N_2			
carbon dioxide	CO_2			
methanol	CH_3OH			
hydrogen peroxide	H_2O_2			
oxygen	O_2			
hydrogen sulfide	H_2S			

Questions and Conclusions

Answer on a separate piece of paper or on the back of this page.

1. Which molecules were nonpolar because all bonds were nonpolar?
2. Which molecules had polar covalent bonds but were nonpolar because of symmetry?
3. Which two shapes appeared to produce polar molecules?